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State of the intensity of the light power of the light-curing lamps of the faculty of dentistry clinic of the University of Cuenca, school year 2021-2022

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Abstract

Objective: The purpose of this study was to determine the intensity of the light power and the integrity of the active part of the curing lights of the Faculty of Dentistry Clinic of the University of Cuenca in the March-August 2022 term. Lack of knowledge of light-curing units, leads dentists to purchase low-quality equipment, thinking that they all work with the same efficiency, compromising the long-term success of restorations. Therefore, it is important to know the ideal characteristics of a light-curing lamp.

Materials and methods: This is a descriptive and observational study whose sample is made up of 72 light-curing lamps assigned by the clinic and the lamps of each student who is attending the clinic. For the development of the project, a radiometer was used.

Results: Of the 72 lamps analyzed, 54 (75%) are LED devices and they correspond to the students. Of which, 47 (87.03%) are effective because they have a power greater than 800 $mW/cm2$. On the other hand, the 18 (25%) are part of the cabin group, in this case there are 15 halogen devices (83.33%) and 3 LED devices (16.67%). Of which, 3 (20%) halogen lamps are effective, while 1 (33.33%) LED device is effective with a power greater than 800 at $mW/cm2$.

Conclusion: An adequate polymerization is crucial to obtain good mechanical and physical properties and excellent clinical results of the material.

Keywords: Curing Lights Dental; Dental Restoration Failure; Biosecurity; Disinfection; Optical Fibers

1. Introduction

The use of light-curing resin led to the creation of the first curing light [1]. The resin contains camphorquinone, which is a photoinitiator that attracts photon energy and binds with the activating amine 2-dimethylaminoethyl methacrylate (DMAEMA), creating free radicals that produce polymerization [1]. At the beginning of the polymerization process, the composite starts the pre-gel stage, where the resin matrix is in a viscous plastic phase, so that the material flows and the monomers continue to slide around the surface to acquire a suitable position [2] [3]. Later in the gel point phase, the resin becomes solid by the formation of macromolecules [2, 3]. Finally, the post-gel stage consists of the rigid elasticity of the material, despite the fact that the composite continues to contract [2, 3].

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An optimal polymerization is crucial to obtain good mechanical and physical properties and excellent clinical results of the material [2]. Otherwise, it can cause significant damage at the pulp level, loss of hardness, poor union between the restorative material and the tooth, increased cytotoxicity and increased absorption and water solubility [2]. There are 5 generations of light-curing lamps [1].

1.1. First generation

1.1.1. Ultraviolet light

It was the first lamp on the market, however, it fell into disuse due to its high carcinogenic potential and its clinical time of 90 seconds [1].

The ultraviolet light system was replaced by the visible light system [1].

1.2. Second generation

1.2.1. Quartz-tungsten halogen

It works through an electric current that passes through the QTH and heats the tungsten up to 27 000 °C, generating infrared radiation and visible light [1]. Among its limitations, we find that its energy is dispersed in a heat form and not visible light, causing a high degree of heat. In addition, due to the dissipation of energy, an incomplete photocuring of the material is produced in very deep areas [1].

1.2.2. High-performance halogen curing light

Light-curing takes less time, however, it causes more heat, therefore it needs a fan and a filter [1].

1.3. Third generation

1.3.1. Plasma arc

It works based on xenon gas and produces high power light, curing the material in 2 seconds [1]. A fan and a filter are needed due to the high heat generation, and they are heavy due to their large size [1].

1.4. Fourth generation

1.4.1. Light-emitting diodes (LEDs)

They are low cost and do not require a filter [1]. It does not produce pulp or gingival damage because it does not generate heat [1]. It reduces working time and cures efficiently [1]. Recharging the battery is required, this being its main disadvantage [1].

1.5. Fifth generation

1.5.1. Argon laser

It is used for minor interventions such as coagulation and gingival scallop [1]. Some of its disadvantages are high costs and poor curing in deep areas [1].

The lack of knowledge of light-curing units leads dentists to purchase low-quality equipment, thinking that they all work with the same efficiency, compromising the long-term success of restorations. Therefore, it is important to know the ideal characteristics of a light- curing lamp [1]:

- Wide emission spectrum
- Ideal light power
- Easy and accessible repair
- Various forms of light curing
- Micro decay of energy with distance
- Adequate duration for the various forms of light curing

This study determines the intensity of the light power and the integrity of the active part of the curing lights of the Faculty of Dentistry Clinic of the University of Cuenca.

2. Material and methods

The present study is descriptive and observational, in which the light-curing lamps assigned by the clinic and the lamps of each student who is attending the clinic have been considered as a universe. With a random sample of 72 from a universe of 160.

The inclusion criteria are lamps that are working correctly and the exclusion criteria are lamps that are deteriorated and not currently working.

For the execution of the research, each student during clinical care was informed about the objectives, procedures, importance of the study and the impact on the dental service. Asking for their participation and after accepting, the intensity of the light power was evaluated with the CK12024 radiometer (it measures the curing time up to 2000). A table was created to record the following data: Lamp number, conditions of the active part of the optical fiber and, the intensity of the light power, which was classified according to the following parameters: Low performance (<300mw/cm2), regular performance (300 – 800 mw/cm2) and high performance (>800 mw/cm2), in a time of 20 seconds and 40 seconds.

2.1. Students

Of the 54 lamps, 1.9% have a power of less than 300 mW/cm2, 1.9% have between 300 and 500 mW/cm2, 9.3% from 500 to 800mW/cm2, and 87% have more than 800mW/cm2.

Of the 54 lamps, 33.3% fiberglass is in good condition, contaminated 18.5%, chipped 3.7%, fractured 3.7%, contaminated and scratched 3.7%, contaminated and chipped 18.5%, and contaminated, chipped and scratched 11.1% and, the 7.4% is contaminated and fractured.

2.2. University

Of the 15 halogen lamps, 6.7% have a power of less than 300 mW/cm2, 0% have between 300 and 500 mW/cm2, 73.3% from 500 to 800 mW/cm2, and 20% have more than 800 mW/cm2.

Of the 15 halogen lamps, 6.7% of them are only contaminated, 13.3% are contaminated and scratched; 53.3% is contaminated, chipped and scratched; 20% is contaminated and fractured and 6.7% is contaminated, fractured and scratched.

There is 1 led lamp in each range (33.3%) except 500-800 (0%).

Of the 3 lamps, 6.7% of them are only contaminated, 13.3% are contaminated and scratched; 53.3% is contaminated, chipped and scratched; 20% is contaminated and fractured and 6.7% is contaminated, fractured and scratched.

Of the 3 lamps, 33.3% of them are in good condition, 66.7% are contaminated, chipped and scratched.

3. Results and Discussion

Krämer (2008) [4] defines the depth of cure as "the decrease in light intensity from the surface to the depth of the composite, caused by the absorption and scattering of light" [4]. The resin fragment that has not been completely polymerized travels towards the oral environment and some patients can cause hypersensitivity and favor the growth of bacteria in the tooth-restoration interface [5]. According to the study by Soh and Yap (2004), when using a low intensity light lamp, it negatively modifies the development of the polymer by becoming a linear chain with greater mobility and resulting in a decrease in hardness. On the contrary, a high-intensity lamp forms denser and cross-linked networks because they generate countless polymer growth centers, therefore there will be greater hardness [6, 7].

In the present study, it was observed that all the students have LED-type lamps, while in the cabins a greater number of halogen lamps was found, despite the disadvantages they have, such as a short useful life and excessive heat [8]. In addition, the halogen lamps have a single power while the LEDs, when turned on, automatically increase their power during the initial 5 seconds, favoring a better marginal adaptation of the placed material. This is confirmed in the study by Pineda (2013), which describes that marginal leakage occurred in 35% of light-cured restorations with LED light devices and in 60% with halogen devices [9].

Of the 72 lamps analyzed, 54 (75%) are LED devices and they correspond to the students. Of which, 47 (87.03%) are effective because they have a power greater than 800 $mW/cm2$. On the other hand, the 18 (25%) are part of the cabin group, in this case there are 15 halogen devices (83.33%) and 3 LED devices (16.67%). Of which, 3 (20%) halogen lamps are effective, while 1 (33.33%) LED device is effective with a power greater than 800 at $mW/cm2$. These results are ratified in the Sierra Vaca study (2018-2019) carried out at the Faculty of Dentistry of the Central University of Ecuador. In this study, it was observed that the 83 lamps studied, equivalent to 51.6%, were effective at an exposure time of 20 seconds, successfully photopolymerizing in the times established in the protocols, since they present irradiance values greater than or equal to 800 $mW/cm2$ [10].

Regarding the fiberglass, in the present study it was obtained that 73.61% is in a deficient state, which affects the photopolymerization of the material, Madhusudhana K et al., ensure that the resin contaminants found in the fiber will interfere with the light intensity of the lamp [11].

4. Conclusion

Adequate polymerization is crucial to obtain good mechanical and physical properties and excellent clinical results of the material, for this reason Rueggeberg recommends using a radiometer to measure the light intensity of the lamps and to be able to determine that they are above 800 $mW/cm2$ favoring the long-term success of restorations [12].

In order not to compromise the restorations, the integrity of the fiberglass of the curing light must be in good condition and this is achieved through protective barriers and disinfection, in this way we also avoid cross-infection.

According to the results obtained within the present study, it can be concluded that the curing lamps of the Faculty of Dentistry are not within the required range. For this reason, it is recommended to replace these lamps by ones that do comply with the established protocols. Otherwise, another alternative to the lack of budget by the institution to acquire new equipment would be for each student to have their own light-curing lamp, which should be previously analyzed with the help of a radiometer to check that they correctly comply with the light-curing process. With these protocols, we would be guaranteeing the long-term success of the restorations carried out within the faculty and at the same time, we would be reducing the risk of cross-contamination.

Compliance with ethical standards

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Disclosure of conflict of interest

There are no conflicts of interest in this work.

Statement of ethical approval

The present research work does not contain any studies performed on animal's/humans subjects by any of the authors.

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